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EXAMINER	
PADGETT, MARIANNE L	
ART UNIT	**PAPER NUMBER**
1762	

DATE MAILED: 04/27/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.	Applicant(s)
10/627,894	Han et al
Examiner	**Group Art Unit**
M.L. Padgett	1762

—The MAILING DATE of this communication appears on the cover sheet beneath the correspondence address—

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, such period shall, by default, expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

☒ Responsive to communication(s) filed on 4/3/03.

☐ This action is **FINAL.**

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle,* 1935 C.D. 1 1; 453 O.G. 213.

Disposition of Claims

☒ Claim(s) 1-26 is/are pending in the application.

Of the above claim(s) 22-26 is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) 1-21 is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claim(s) _____ are subject to restriction or election requirement

Application Papers

☐ The proposed drawing correction, filed on _____ is ☐ approved ☐ disapproved.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119 (a)-(d)

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119 (a)-(d).

☐ All ☐ Some* ☐ None of the:

☐ Certified copies of the priority documents have been received.

☐ Certified copies of the priority documents have been received in Application No. _____.

☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a))

*Certified copies not received: _____.

Attachment(s)

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). 11/3/03

☒ Notice of Reference(s) Cited, PTO-892

☐ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Interview Summary, PTO-413

☐ Notice of Informal Patent Application, PTO-152

☐ Other _____

Office Action Summary

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:

I. Claims 1-21, drawn to a process for "plasma curing" a porous dielectric material with $CH_4 + N_2$, and no F in the gas, classified in class 427, subclass 535+.

II. Claims 22-26, drawn to a F-free porous dielectric material or a device containing it, classified in class 428, subclass 411.1+, possibly 497.

2. The inventions are distinct, each from the other because:

Inventions Group I and Group II are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product can be made by different processes, since the dielectric materials have no particular composition, except that they are F-free (maybe, its ambiguous, possibly only the gas need be F-free, but the dielectric material of the process may include F, whereas the group II product may not). With no specific dielectric chemistry involved in the curing, the choice of curing techniques or gas used therewith, provides for no specific or necessary product structure as how a specific gas will react to an unknown dielectric composition is another unknown, hence any curing technique (UV, heat, electron beam, etc.) or gases may be used therewith (except F) which may produce claimed physical values in the otherwise unspecified porous dielectric.

3. Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

Because these inventions are distinct for the reasons given above and have acquired a separate status in the art because of their recognized divergent subject matter, restriction for examination purposes as indicated is proper.

Because these inventions are distinct for the reasons given above and the search required for Group II is not required for Group I, and visa versa, restriction for examination purposes as indicated is proper.

4. During a telephone conversation with Brian Smiler on March 8, 2004 a provisional election was made Group I, method traverse to prosecute the invention of method claims 1-21. Affirmation of this election must be made by applicant in replying to this Office action. Claims 22-26 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

5. Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

6. Claims 1-21 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In the preamble "fluorine-free plasma cured material" is ambiguous, because it is unclear if the adjective "fluorine-free" applies to the "plasmas", to the "material" or to both, hence the preamble, and the results it implies for the process of the body of the claim is ambiguous. It is noted that in lines 2 thru the end of the claim, that the "porous dielectric material" is not excluded from containing F, and that only the "plasmas gas" (line 4) must be free of fluorine, so that while a plasma might remove F from, for

example a fluorocarbon dielectric material, such reaction products or by-products are not the "plasma gas", but could contradict possible meanings of the preamble.

In claim 3, while "the organic dielectric material" is further defined as HSQ (hydrogen silsesquioxane) or MSQ (methyl...), the option of "organic ..." from the Markush group of claim 2 was NEVER positively selected, hence technically any inorganic or combination inorganic /organic may still read on claim 3 with the presence of any MSQ or HSQ.

7. Claims 1-21 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter, which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

While the examiner notes applicant's stated intent in [0024] that "the process of the present invention is applicable to virtually any porous dielectric material", the examiner found NO supporting evidence in applicant's specification, that a N_2 +CH_4 plasma has the same relative effects on dielectric constant, modulus of elasticity and hardness on ALL types of [porous] dielectric material. In the summary [0015] indicates that the process is intended for "porous low-k materials", which is narrower than the scope claimed, although low is a relative term that would need proper definition, it is significantly different from all dielectrics. In applicant's extensive list of useful coating compositions [0025-0038], every single example appears to be a siloxane, a silane or a silyl-containing compound, thus ALL suggested porous dielectric materials are Si-containing. The examiners finds absolutely no evidence that the (CH_4 + N_2) plasma will have the same effect on fluorocarbon polymers, such as Teflon, or various polyolefins or polyamides, etc., that are porous (i.e. have been foamed, or otherwise made porous), as it will on the listed Si-containing., compounds. Therefore, the scope of the claims as written does not appear to be enabled. To exemplify this issue, see Shi et al (6,265,320 B1), which plasma etches dielectric materials (organic insulating layer) using gases that may be a mixture of N_2 + CH_4, and may

additionally contain Ar, He and/or H_2, with claimed CH_4: N_2 ratios. While the organic polymers are not discussed as porous, that physical difference will not significantly change the plasma's chemical effect.

With respect to the comparison between the F-free plasma cured porous dielectric material and the furnace (thermally) cured porous dielectric material, which relates to claim 21, it is difficult to extract any meaningful information from this comparison [0058-0060], as it does not appear to be directed to any specific material, but makes a vague statement about "dielectric materials of the present invention ... comparable ...to furnace cured materials." Does this apply to all the pages of various Si-containing compounds, or to all (porous) dielectrics in existence as claimed, or some other range of options? It is noted that [0061] limits its out gassing comparisons or conclusions to "oliomeric polysilica and other substances from the porous films compared to furnace or thermal cured low-k film", but again not providing evidence of enablement for the breath of the claimed scope.

8. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); and, *In re Thorington,* 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly

owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

9. Claims 1-21 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-33, 50-52 and 55-66 of copending Application No. 10/623,729, in view of Shi et al (6,284,056 B1). The 10/623,729 application differs from the present application by first employing UV curing, then plasma treating (claim 28-33), where the plasma gas used may be the claimed combination of $N_2 + CH_4$. Also, the material being cured by the (729) application need not be porous, although porous is not excluded, but the present application starts the claimed process with a material or film that has already been sufficiently processed or treated to be a porous dielectric material, then "plasma cures" with plasma gases as claimed by (729). In both cases, material being treated may be HSQ or MSQ; or a combination thereof when specific compounds are given. It would have been obvious to one of ordinary skill in the art that the creation of the initial porous dielectric material of the present case has some initial curing steps, and it would have been expected for one of ordinary skill in the art to use processes known in the art to achieve the initial state.

Shi et al teach UV treatment of deposited organic polymers (CVD or spin-on materials) or spin-on materials such as HSQ or organo silsesquioxanes, or nanofoam polymers or aerogels or porous polyamides or nanofoam silica aerogels (abstract; column 2, lines 24-44, column 4, lines 48-68; and column 6, lines 25-38). The post deposit UV treatment may be for 10 to 500 sec., or typically 10-90 sec; use 100-600 mW/cm^2 for wavelengths between 200 and 450 nm. Substrate temperatures during UV treatment be up to 450°C, in gases such as N_2, O_2, H_2, CF_4, Ar, He, etc., at pressure from several torr to slightly above atmospheric. After UV exposure, annealing is preferred using the above gases or vacuum

(column 4, lines 10-20; column 5, line 1-16^{+} and column 6, lines 13-25). The examples provide additional parameter teachings, such as annealing for one hour in N_2 at 400°C. Post-deposition UV treatment is taught to advantageously improve the adhesion, film cohesion, hardness, and thermal stability of polymer films and reduce subsequent outgassing (column 1, lines 37-48; column 4, lines 48-55 and column 6, lines 25-29), with the background mentioning that organic polymer films typically have dielectric constants between 1.5 and 3.

Given teachings of Shi et al that treat like materials, and the present claims, where the "plasma curing" is after porous film or material formation, it would have been obvious to use UV treatment techniques as taught by Shi et al, followed by the present cases' "plasma curing", especially as Shi et al recommends post-treatments involving heat after UV curing.

Note that as the present case is more generic than (729) in not claiming the multi-stage treatments as does the (729) case, and that the instant claims may be considered a substep of or the plasma species of (729)'s "post-UV treating" when considered in view of Shi et al, as discussed above.

This is a provisional obviousness-type double patenting rejection.

10. Other curing art showing HSQ or MSQ or silsesquioxanes being cured with various sources, such as UV, include Arkles et al (5,853,808) and Nakamura et al (2001/0029283 A1), who also indicate that combinations of curing techniques may be employed.

11. Ho (6,620,733 B2) is cited as providing further evidence that claimed plasmas (N_2 + Ar + H_2 + CH_4) will not have the claimed effects on all dielectric materials as claimed, specifically not on all low-K dielectric materials. See abstract; column 3, lines 40-55; Summary; column 5, lines 3-10, 22-38, and 66- column 6, lines 8 and 48- column 7, line 13; and Ex. 1-3 in column 8.

12. Claims 1-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Catabay et al (6,346,490 B1), in view of Usami (6,133,132) or Chung et al (6,231,989 B1) or Lui et al (6,647,994 B1).

Catabay et al (abstract; summary; column 3, line 17- column 4, line 55; column 6, lines 5-55) teach plasma treating low-k C-containing Si oxide dielectric material that may have been had via holes formed therein. The plasma treatment uses a hydrocarbon gas, such as CH_4, and may be accompanied by one or more non-reactive gases, such as Ar or He. This plasma treatment may be combined with N_2 densification, which would have been expected to be harder than the initial dielectric, and which implies that the initial untreated dielectric is relatively porous in order for densification to be induced, although no explicit teaching concerning porosity or lack thereof is found in Catabay et al. Relevant plasma parameters include temperature of 25-450°C, preferred pressures of about 1-3 torr, and times of 30 sec. up to about 6 min., where 3 minutes treatment is typical. While no generalized range of CH_4 to N_2 flow rates is given, an example of 12 vol. % CH_4 to 88 vol. % N_2 is given, or about 0.1. Optimization dependent on other variable parameters; specific plasma chamber and confirmation, and specific dielectric materials would have been expected to use a range of ratios, including lower ones as claimed.

No comparison of before and after plasma treatment values, relative or specific, for the claimed dielectric constant, elastic modulus or hardness is given, however the relationship as claimed is implied as noted above. As there is no necessary critical difference from the plasma process as practiced by Catabay et al, like values for these physicals properties of dielectric material would have been expected. Note, that the PTO cannot test for the values and relationships not explicitly discussed, but use of plasma parameters overlapping or insignificantly different, provide an expectation of like results.

As noted above while there are implications that Catabay et al's low-k dielectric is porous, it is never explicitly said to be so, however an expectation of like results.

As noted above, while there are implications that Catabay et al's low-k dielectric is porous, it is never explicitly said too be so, however any of Usami (137: abstract; column 1, lines 5-7 & 19-51; column 2, line 19-24; column 3, line 7-21; column 4, line 30-46; and column 5, lines 34-45); or Chung et al (989 B1: abstract; column 3); or Lui et al (abstract; column 1, lines 30-55; column 2, lines 28-65;

column 3, lines 27-40); provide teachings of low-k dielectrics, such as MSQ, with Si and C containing groups as taught by Catabay et al, that are porous materials used in processes analogous to those of the primary reference, hence would have been obvious to use therein by virtue of providing means of making suggested material, being supportive of implied and explicitly required characteristics.

13. Smith et al (6,599,824 B2) is also interest for using plasma that may include $CH_4 + N_2$, etc. gases to remove a photoresist on dielectric material, such as HSQ, aerogels, etc., (abstract, column 5), but do not discuss the effect thereof on the dielectric. Gilbert el al (6,576,646 B2) is of interest for using claimed plasmas, on dielectrics, but creates conductive layers thereby.

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Marianne L. Padgett whose telephone number is (571) 272-1425. The examiner can normally be reached on M-F from about 8:30 to 4:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive Beck, can be reached on (571) 272-1415. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

M.L. Padgett/dh
April 22, 2004
April 25 & 26, 2004

MARIANNE PADGETT
PRIMARY EXAMINER